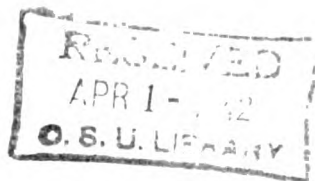


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DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
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INFORMATION CIRCULAR

STRONTIUM MINERALS



BY

CHARLES L. HARNESS

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

STRONTIUM MINERALS^{1/}

By Charles L. Harness^{2/}

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INTRODUCTION

As in World War I, military uses have expanded tremendously the demand for strontium compounds and aroused interest in possible domestic sources of strontium minerals. World War II, however, has not created a ready market for domestic celestite (strontium sulfate) and strontianite (strontium carbonate), as imports of British celestite have virtually kept pace with demand, and a new source of supply has been found in Mexico.

ECONOMIC BACKGROUND OF THE INDUSTRY

Before 1914 American requirements of strontium salts were small and were met by imports from Germany, chiefly in the form of the nitrate. Extensive deposits of celestite and strontianite were known to occur in the Western States, but they were undeveloped because the cost of transporting the minerals to the markets on the Atlantic seaboard was prohibitive. Great Britain had been shipping celestite to Germany, where it was converted into strontium hydrate, which was used in the sugar-beet industry, and into strontium nitrate and other strontium chemicals, of which

^{1/} The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7200."

^{2/} Nonmetal Economics Division, Bureau of Mines.

relatively large proportions were exported. Great Britain, although the primary producer of celestite, depended upon Germany for strontium chemicals. Stocks of these chemicals in England were virtually exhausted by 1916 in the manufacture of tracer bullets, military flares, rockets, and similar pyrotechnic products requiring a dazzling red light; and late in 1916 an embargo was placed on exports of strontium chemicals and minerals to the United States, which remained in effect until this country entered the war in 1917. The shortage and high price of strontium minerals (celestite was \$6 a ton in 1914 and over \$20 in 1917, delivered at New York) led to the opening of deposits in the western United States, and in 1916 about 250 tons of strontium minerals was produced, much of which was manufactured into strontium salts. In 1917, 4,035 short tons of strontium minerals (about 90 percent celestite and the remainder strontianite) was produced domestically, and after April of the same year, 17,000 tons of celestite was imported from Great Britain. In 1918, 400 short tons of strontianite was produced; then the mines were forced to close because of British competition. Imports of British celestite were 1,135 tons in 1918, 2,093 tons in 1919, and 3,879 tons in 1920.^{3/} By 1920 the beet-sugar industry had recovered, and the bulk of British celestite exports again went to Germany. Between 1920 and 1939, however, annual German imports averaged only 2,000 to 3,000 tons of celestite, whereas before World War I they had ranged from 4,000 to 5,000 tons. Germany soon regained its former dominating position in the strontium chemicals field, and after World War I the United States continued to import celestite mainly from Great Britain and strontium salts from Germany.

Soon after the outbreak of hostilities in 1939, imports of strontium salts from Germany were cut off completely, but receipts of strontium minerals were well-maintained, 2,751 tons valued at \$28,686 being imported in 1940 compared with 2,823 tons valued at \$23,133 in 1939. Strontium metal and salts were placed under United States export control in 1940. Anticipating large demands for strontium salts, producers hastened to open old deposits in 1940, most of which had not been worked since 1918. The anticipated shortage of celestite did not develop, however, and by the latter part of 1941 shipments of British celestite to American consumers had increased. Of the 3,172 tons of celestite valued at \$49,367 imported in the first 9 months of 1941, 2,854 tons valued at \$42,999 was from Great Britain and 419 tons valued at \$6,368 was shipped from newly developed Mexican celestite properties, which began exporting early in 1941. The few hundred tons of domestic strontium minerals that found a market in 1940 were mostly trial orders.

^{3/} Data from British export schedules.

It costs \$16.40 per short ton to haul strontium ores from California to Philadelphia or New York City in carlots (40 tons). The development of a domestic strontium minerals industry continues to be handicapped because it has to compete with pure and cheap celestite from Great Britain, and this situation may continue as long as bottoms are available for celestite at ballast rates. Even in 1940 the ocean rate was only \$5.90 a short ton. Imports of strontium minerals are duty free and the relatively small peacetime requirements of strontium compounds are a further deterrence to the formation of a domestic industry.

STRONTIUM MINERALS

The only strontium minerals of commercial value are celestite (the sulfate, SrSO_4) and strontianite (the carbonate, SrCO_3). Brewsterite (the silicate) has no economic importance. Pure celestite is blue, but commercial celestite is usually white or reddish, coarsely crystalline, and transparent to translucent. The commercial product has a fairly high density, 3.96, and is insoluble in acids. Strontianite is crystalline and transparent to translucent; the color varies according to impurities, from white to green or yellow, and the density is 3.7. Theoretically celestite contains 56.5 percent strontium oxide and strontianite, 70.2 percent strontium oxide, but materials of such purity are never found in nature. Typical analyses of the two ores are:

<u>Celestite (England)</u>		<u>Strontianite</u>	
	<u>Percent</u>		<u>Percent</u>
SrSO_4	96.55	SrCO_3	90.9
SrCO_3	.17	CaCO_3	7.5
BaSO_4	.25	BaCO_3	.1
CaSO_4	.54	Fe_2O_3	.05
MgCO_3	.15	Al_2O_3	.1
Fe_2O_3 }	.90	SiO_2	.04
Al_2O_3 }		S	.1
SiO_2	1.33	P	.005

Strontianite frequently contains 7 to 20 percent of calcium carbonate, which is isomorphous with strontium carbonate. Although strontium salts are more easily manufactured from strontianite than celestite, strontianite containing calcium cannot be used for many purposes. Strontianite is soluble in hydrochloric acid and thus can be distinguished from celestite.

MINING AND PREPARATION

In Great Britain deposits of celestite are found by means of a boring tool about 9 feet long which is drilled into the ground until a comparatively hard bed is reached. From the nature of the grinding through the hard bed

the experienced operator generally can tell whether the material is celestite or some other mineral. When a deposit has been located a pit is dug with picks and shovels, and the celestite is quarried with sledges and crowbars. A fair-size pit is about 20 feet square and 15 to 20 feet deep. The celestite when excavated is roughly hand-trimmed into lumps of different sizes (about 9 to 12 inches across) and stockpiled, awaiting removal. Before the current war American importers preferred lump material to fines, which were consumed largely in the British market. Dealers now accept both fines and powdered material. In the United States the lumps are broken in a jaw crusher to smaller sizes (about 2 1/2-inch pieces), dried in a rotary oil-fired drier, crushed in a secondary crusher to 3/4-inch lumps, then pulverized in a ball-race mill to 90 percent minus 325-mesh, air-floated, and bagged.

In Westphalia, Germany, strontianite usually occurs in nearly vertical veins ranging from less than 1 inch to about 7 feet in thickness. The width of the veins averages about 8 to 12 inches. Veins less than 2 inches thick are rarely worked. The deposits are mined by overhead stoping, which contributes substantially to the cost. The run-of-mine material contains 10 to 15 percent strontianite and is concentrated at the surface by mechanical washing and hand sorting to a produce containing approximately 85 percent strontium carbonate. The material is usually marketed in lump form.

UCES Strontium Minerals

The chief uses of celestite are as a filler and in the manufacture of strontium compounds. Strontianite is employed in the steel industry and in making strontium salts and compounds.

Ground celestite has been used to some extent as a substitute for barite as a filler, particularly in colored paints, sealing compounds for electric batteries, asphaltic compositions, rubber, and sealing wax. Considerable ground celestite is employed in purifying caustic soda for the rayon industry. A pigment analogous to lithoponc has been made from celestite.

Strontianite added to a basic open-hearth steel furnace acts as a flux, increasing the fluidity of the slag without reducing its basic character, and it does not damage the furnace lining. The main advantage claimed, however, is that it removes most of the sulfur and phosphorus that are present in certain European pig iron and scrap steel. Owing to the higher quality of domestic pig iron and scrap, no large consumption of strontianite in the domestic steel industry is indicated at present.

Strontium Chemicals

The chief military use of strontium compounds is in tracer bullets, and this use alone requires astonishingly large quantities of strontium salts. Strontium nitrate, peroxide, and oxalate are standard constituents of charges for tracer bullets. Every fifth bullet fired in 0.30- and 0.50-caliber machine guns used by American aircraft, tanks, and ground forces is a tracer bullet. In American practice the same type of tracer bullet is employed for both day and night firing. In contrast, the British use a number of types of tracer bullets for specialized work, particularly in aircraft. The two chief strontium compounds used in tracer work are probably the nitrate and peroxide. Undoubtedly the expanded use of rapid-fire small arms in air and tank warfare will require much larger quantities of strontium compounds than were consumed in World War I.

The use of strontium compounds in highway, railroad, aviation, and marine signals, Very pistols, and military flares is minor compared to its consumption in tracer bullets, but considerably more information is available concerning these uses.

American railroads have used red, yellow, and green fusees for various emergencies for many years. In the red fusees the color is due to a strontium salt. Barium salts give a green color and sodium salts a yellow color. A typical formula for red fusees is:

	<u>Percent</u>
Strontium nitrate.....	71.1
Potassium perchlorate...	13.1
Sulfur.....	11.1
Sawdust.....	4.2
Charcoal.....	0.5

The ingredients must be dry, of a standard fineness, and intimately mixed. The powder is inserted mechanically into stout paper tubes 7 inches or more in length and about 1 inch in diameter. A spike in the bottom of the tube permits the fusee to be driven into the ground. Standard railway fusees burn for 5 or 10 minutes, depending on size.

In several States trucks on the highway are required to have at least two 15-minute red fusees, which are to be ignited in case of accident or when making repairs at night.

Marine distress signals are virtually a necessity on small watercraft that have no radios. The Bureau of Marine Inspection and Navigation, Department of Commerce, requires a hermetically sealed container carrying

a pistol and 12 red parachute flares to one of every three lifeboats on a coastwise vessel and on each lifeboat of a transoceanic vessel. The red parachute signal is shot from the pistol, reaches a height of 300 to 400 feet, and produces 30,000 candlepower of light. The larger marine distress rocket for use on deck attains a height of 800 to 1,000 feet, where it liberates a shower of red stars.

A red-star parachute flare is used as an aviation distress signal. The flares are held in racks in the cockpit of the plane, and a pistol is provided to project the flare well beyond the plane. The parachute retards the fall of a flare and is generally attached to the charge with asbestos filaments.

Air arms of the United States military service use a strontium flare that will float on water and thus expose the movements of enemy naval units. The United States Army uses a red flare that can be fired from a special mechanism attached to the Springfield rifle or released from a submerged submarine.

The following list indicates the chief uses of the various strontium salts in civilian industry.

Strontium compound:

Use

Acetate	Medicine (intestinal vermifuge).
Arsenite	Medicine (alterative).
Bromide	Medicine.
Carbonate	Iridescent glass; medicine.
Chlorate	Pyrotechnics.
Chloride	Pyrotechnics; medicine.
Hydroxide	Sugar industry.
Iodide	Medicine.
Lactate.....	Medicine (treatment of rheumatism, gout).
Nitrate	Pyrotechnics; matches.
Oxalate	Pyrotechnics.
Oxide	Pyrotechnics; glass; photographic reagent; paint filler; medicine.
Peroxide.....	Bleaching agent; bleaching sugar; pyrotechnics.
Alpha-phenylcinchoninate (Iriphan; Triphan).....	Medicine (treatment of rheumatism and gout, diuretic).
Phosphate	Medicine (tissue builder).
Salicylate	Medicine and pharmaceuticals.
Sulfate	Glass; ceramics; pyrotechnics; paper.

The medicinal uses of strontium salts are declining.

In Germany the chief use of strontium compounds is in the Scheibler desaccharization process, which is said to recover a larger percentage of the sugar than the cheaper lime process used in other countries, including the United States. Crude beet-sugar molasses contains about 50 percent sugar with numerous impurities, and pure sugar cannot be recovered simply by crystallization of the crude molasses. By a process known as desaccharization, however, strontium hydroxide is added to the molasses, and the sugar (sucrose) is removed from the impure molasses as an insoluble saccharate of strontium. The strontium saccharate is filtered, washed, and suspended in water, then carbon dioxide gas is added. Strontium carbonate precipitates, leaving the pure sugar in solution. In the somewhat similar American process, slaked lime is employed instead of strontium hydroxide and calcium carbonate is precipitated. Pure sugar is recovered from the remaining solution by crystallization. In Germany the strontium carbonate is calcined and used again, but in the United States the calcium carbonate is thrown away.

DOMESTIC OCCURRENCE

Virtually the only commercial deposits of strontium minerals in the United States have originated as precipitates formed by the drying of Tertiary Lakes or as replacements of calcium in limestone. East of the Mississippi River few deposits with commercial possibilities have been discovered. Several Western States, however, particularly Arizona, California, and Washington, have large deposits of celestite and its weathering product, strontianite.

Celestite is found mainly in beds or veins in clays, sandstones, or limestones, and strontianite generally occurs in veins in limestones and marls.

Arizona

A deposit of celestite containing reserves estimated at 180,000 to 200,000 tons occurs in the Vulture Mountains, Maricopa County, 15 miles southeast of Aguila. The celestite forms beds as much as 3 1/2 feet thick in a series of shaly tuffs and is more or less silicified. In 1940 the owner reported to the Bureau of Mines that the celestite concentrates ran about 70 percent strontium sulfate.

During the war of 1914-18, celestite deposits 15 miles south of Gila Bend were operated and shipments made to Los Angeles, Calif. The mineral from this deposit is massive and finely crystalline. The color is

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generally light but ranges from a pink to darker shades. The purity ranges from 67 to 91.5 percent strontium sulfate.

California

The largest known reserves of domestic celestite are in California. A deposit estimated at 600,000 tons lies on the south slope of the Cady Mountains near Argos, San Bernardino County. One analysis shows 92.6 percent strontium sulfate. The deposit was worked by open-pit methods in 1940.

Celestite deposits associated with gypsum and manganese are found in the Avawatz Mountains, San Bernardino County, about 10 miles west of the Tonopah & Tidewater Railroad and about 15 miles southwest of Tecopah station, and were exploited during World War I. The deposits occur throughout a belt 9 miles long and 1 1/2 miles wide in steeply dipping Tertiary Lake beds. Most of the celestite is reddish or brown from iron oxide, manganese oxide, or both, and clay, but much of it is of lighter color. It is reported that rock carrying 85 to 91 percent strontium sulfate can be obtained. Reserves are estimated at 12,000 short tons.

Celestite has been found in several beds in the low hills north of Lavic, San Bernardino County, and deposits in this area were worked in 1940.

Open-pit production of strontianite in 1940 was reported from a deposit 10 miles north of Barstow, San Bernardino County. The material occurs in hard, shaly tuffs and contains as high as 78.6 percent strontium carbonate.

A bed of celestite about 10 feet thick, overlying a bed of gypsum 150 feet thick in the Fish Mountains, Imperial County, was exploited during World War I. The material, which analyzes about 93.8 percent strontium sulfate, was shipped to Los Angeles in 1916-17, where it was used by two chemical plants in the manufacture of strontium nitrate. The deposit was reopened in 1940 and worked as an open pit.

Ohio

Near Genoa, Ottawa County, veins of celestite deposited by water circulating in limestone were hand-sorted in 1940 in conjunction with limestone operations and shipped.

Texas

For several years considerable celestite running 80 percent strontium sulfate has been mined near Sweetwater, Nolan County, by the Mudrite Products Corporation, whose headquarters are in Houston. The material is sent to Nacogdoches, where it is ground and shipped as an oil-well drilling admixture.

Washington

A deposit of celestite partly weathered to strontianite, which outcrops 1 mile southwest of La Conner, Skagit County, was first opened during World War I. The deposit, which contains reserves estimated at 10,000 to 12,000 tons, was reopened in 1940 and is being worked by both underground and open-pit methods. A similar deposit is reported to occur at the mouth of Ruby Creek, on the Skagit River, in Whatcom County.

Deposits of strontium minerals have also been reported in Arkansas, Michigan, New York, Pennsylvania, Utah, and West Virginia.

DOMESTIC PRODUCTION

Both celestite and strontianite were produced during World War I. Production then lapsed until recent years, when some celestite was produced in Texas as a drilling-mud admixture (production figures confidential), and in 1940 several producers again shipped both celestite and strontianite. Available production data for the past 30 years follow:

Production of strontium minerals in the United States, 1916-40 (short tons)

Year	Celestite	Strontianite	Total
1916	240	10	250
1917	3,630	405	4,035
1918	--	400	400
1940	(1/)	(1/)	350

1/ Production data for individual minerals confidential.

IMPORTS

The following table gives imports for consumption of strontium minerals and compounds into the United States. Fairly large stocks of celestite are normally kept on hand by domestic consumers, and the low import figures for 1930-32 and 1938 indicate that excess inventories had been accumulated in 1929 and 1937. Virtually all the strontium compounds were imported from Germany.

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Imports for consumption of strontium minerals and compounds into the
United States

Year	Strontianite and celestite 1/		Strontium nitrate		Strontium carbonate precipitated		Strontium oxide	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1910 ^{2/}	(3/)	4/ \$287	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1911 ^{2/}	(3/)	4/ 44	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1912 ^{2/}	-	-	-	-	-	-	-	-
1913 ^{2/}	(3/)	4/ 474	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1914 ^{2/}	(3/)	4/ 1,969	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1915 ^{2/}	(3/)	4/ 7,268	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1916 ^{2/}	(3/)	4/ 8,311	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1917 ^{2/}	(3/)	4/ 21,184	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1918	(3/)	4/ 2,459	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1919	4/ 1,225,952	3,380	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1920	4/ 1,659,083	15,476	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1921	4/ 1,212,758	4,393	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1922	4/ 390,644	22,986	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1923	4/ 5,231,818	131,420	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1924	4/ 1,212,758	4,393	(3/)	(3/)	(3/)	(3/)	(5/)	(5/)
1925	2,264,303	22,082	2,467,011	137,266	94,635	3,065	665	120
1926	4,399,142	58,159	1,027,248	56,643	50	11	6,604	623
1927	2,711,468	58,711	1,509,350	88,244	12,998	2,428	-	-
1928	1,517,801	31,157	1,767,550	99,579	92,908	5,584	2,205	241
1929	1,945,577	45,505	2,569,407	145,330	61,138	5,157	2,205	241
1930	440,924	10,459	1,678,883	92,166	33,978	2,182	-	-
1931	260	123	1,701,750	80,889	29,452	2,022	1,252	520
1932	11,685	276	438,931	18,699	30,550	2,211	-	-
1933	2,426,493	8,457	532,835	23,744	10,073	850	595	115
1934	2,500,411	9,218	237,105	13,796	28,416	3,284	2,204	469
1935	2,674,094	11,595	277,548	15,716	21,828	2,641	-	-
1936	3,880,302	14,537	694,696	39,820	6/ 52,311	6,056	(7/)	-
1937	5,636,570	20,877	609,488	40,243	6/ 44,579	4,610	(7/)	-
1938	552,868	2,824	364,362	23,921	6/ 82,859	8,502	(7/)	-
1939	5,645,935	23,136	479,933	32,060	6/ 23,136	2,811	(7/)	-
1940	5,502,029	28,686	-	-	-	-	-	-

1/ Chiefly celestite from Great Britain during 1925-40.

2/ Fiscal year ended June 30.

3/ Data not available.

4/ Includes only strontianite, strontium oxide, and strontium peroxide.

5/ Imports, if any, included with strontianite.

6/ Includes oxide, if any.

7/ Imports, if any, included with strontium carbonate.

Imports by countries in 1939, 1940, and the first 7 months of 1941 follow:

Imports by countries, 1939-41

	Strontium minerals 1/		Precipitated strontium carbonate and strontium oxide		Strontium nitrate	
	Pounds	Value	Pounds	Value	Pounds	Value
1939						
United Kingdom..	5,623,228	22,330	-	-	-	-
Tunisia.....	22,487	295	-	-	-	-
Germany.....	220	11	23,148	2,811	479,933	32,060
	5,645,935	23,136	23,148	2,811	479,933	32,060
1940						
United Kingdom..	5,457,229	28,406	-	-	-	-
Tunisia.....	44,800	280	-	-	-	-
	5,502,029	28,686	-	-	-	-
1941 2/						
United Kingdom..	5,503,716	42,999	-	-	-	-
Mexico.....	836,782	6,363	-	-	-	-
Total.....	6,343,498	49,367	-	-	-	-

1/ Chiefly celestite.

2/ First 9 months.

STRONTIUM INDUSTRY IN FOREIGN COUNTRIES

Aided by low mining and shipping costs, Great Britain normally supplies virtually the entire world requirements for celestite. In normal times Germany produces and exports small quantities of strontianite. Strontium minerals are mined to a small extent from time to time in several other foreign countries, particularly France, Sicily, and Tunisia, but little is exported. Mexico entered the field with shipments of celestite early in 1941.

Great Britain

British celestite is quite pure, as indicated by the analysis on page 8557. Both strontianite and celestite are found at many localities in England and Scotland, but commercially important quantities of strontium minerals appear to be limited to the celestite deposits of Gloucestershire and Somerset, where operations were commenced in 1874. At present the workings are confined to a strip about 1,800 feet wide extending from

Yate to as far south as Golden Valley, or about 7 miles. The output has been about 400,000 tons. No data are available as to reserves. The mineral, which is generally produced in the form of lumps, is cleaned and roughly hand-trimmed at the pits, carted to Yate and other stations on the Midland Railway in Gloucestershire, and delivered at Bristol.

Production of celestite in the United Kingdom, 1913-38

Year	Short tons	Year	Short tons	Year	Short tons
1913	20,636	1922	5,277	1931	4,538
1914	14,735	1923	7,152	1932	7,674
1915	717	1924	1,624	1933	4,325
1916	2,815	1925	1,201	1934	10,573
1917	2,886	1926	426	1935	5,051
1918	1,136	1927	2,405	1936	6,396
1919	2,097	1928	7,981	1937	8,509
1920	4,685	1929	5,969	1938	5,148
1921	7,487	1930	5,758		

Exports of celestite from Great Britain, 1918-33, in short tons

Year	To Germany	To United States	To other countries	Total
1918	-	1,135	-	1,135
1919	-	2,096	-	2,096
1920	397	3,879	-	4,276
1921	7,830	-	-	7,830
1922	7,311	-	62	7,373
1923	7,664	1,748	185	9,597
1924	1,580	1,469	474	3,523
1925	1,123	674	703	2,507
1926	-	949	722	1,671
1927 ^{1/}	-	-	-	4,538
1928	-	-	-	5,360
1929	-	-	-	3,360
1930	-	-	-	3,596
1931	-	-	-	1,351
1932	-	-	-	3,170
1933 ^{2/}	-	-	-	1,512

^{1/} Data by countries not available after 1926.

^{2/} Celestite not separately recorded after 1933.

Until recent years British requirements of strontium salts were met by imports from Germany, except for 1914-18. In 1937, however, the firm

of Albright & Wilson, Ltd., Birmingham, began the commercial production of strontium salts, including the nitrate, chloride, carbonate, and oxalate.

GERMANY

Both celestite and strontianite have been produced in Germany. The chief sources of native German strontium ore, however, have been numerous irregular veins of strontianite around Munster, in Westphalia. The output has totaled about 80,000 metric tons. Production began in 1840 and rose from 34 short tons a year to 220 tons a year in 1875. By 1884 the demand for strontium hydroxide in the sugar-beet industry had caused an increase in annual production to 8,829 short tons, and more than 2,000 persons were employed in mining the material. After 1884 the strontium-minerals industry was dominated by British celestite, and production of Westphalian strontianite gradually declined. Its resumption on a restricted scale after World War I is due largely to the development of new uses, notably in the iron and steel industry.

Production data are shown in the following table.

Production of strontianite in Germany during specified years, 1840-1937

Year	Short tons	Year	Short tons	Year	Short tons
1840	34	1920	77	1929	861
1875	220	1921	683	1930	409
1883	8,340	1922	330	1931	146
1884	8,850	1923	(1/)	1932	73
1915	28	1924	683	1933	168
1916	176	1925	896	1934	381
1917	358	1926	(1/)	1935	207
1918	304	1927	795	1936	289
1919	46	1928	975	1937	300

1/ Not available.

Strontianite is not separately classified in the German export schedule but is combined with witherite. In 1937 exports in this classification were 495 metric tons; 1938 shipments were 363 tons.

Much of the celestite obtained from Britain, as well as the Westphalian strontianite, is converted to strontium chemicals for home consumption and export. Recent export figures follow:

Exports of strontium compounds (precipitated carbonate, chloride, oxide,
and hydroxide) from Germany, 1923-38 1/

Year	Metric tons	Year	Metric tons
1923	38	1931	40
1924	28	1932	19
1925	436	1933	32
1926	1,318	1934	38
1927	1,232	1935	53
1928	335	1936	56
1929	743	1937	91
1930	454	1938	37

1/ About 90 percent to the United States.

Imports of British celestite into Germany enter through the port of Hamburg and are reported with imports of barite. Receipts of the latter mineral are negligible, however, and the data below represent mainly celestite from Great Britain.

Imports of celestite and barite into Germany, 1925-38

Year	Metric tons	Year	Metric tons
1925	2,338	1932	4,557
1926	738	1933	933
1927	3,693	1934	2,804
1928	5,455	1935	2,533
1929	3,672	1936	2,252
1930	3,143	1937	391
1931	2,708	1938	758

Mexico

According to the American commercial attache at Mexico City the following firms are producers of celestite:

Minera Industrial, Apartado 332, Monterey, N. L.
O. L. Wise, Apartado 41, Matehuala, S. L. P.

Specimens of celestite offered by the second firm have been reported to contain 93.5 percent SrSO_4 , 3.08 percent CaSO_4 , and 2.80 percent BaSO_4 .

PRICES

The trial-order prices received for celestite by domestic producers in 1940 ranged from \$15 to \$20 a ton, f. o. b. mines, for crude material.

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No chemical analyses of shipments are known, but dealers indicated that the purity did not equal that of British celestite, which contains 92 to 96 percent strontium sulfate. The nominal trade-journal quotation for celestite, 92 percent minimum strontium sulfate, finely powdered, carlots, was \$45 a short ton in December 1941: The nominal strontianite price was \$55 a ton for material analyzing a minimum of 84 percent strontium carbonate.

In 1939 the average price per short ton of celestite f. o. b. Bristol docks was about \$12, or about \$16 a ton delivered at New York. In 1940 the price at Bristol declined to between \$10 and \$11 a short ton. The average value at Bristol for the first 7 months of 1941 rose to \$13 a short ton, and shipping rates to the Atlantic seaboard increased from \$4.40 a short ton in 1939 to \$5.90 a short ton in 1940. The increase was due to a 33-1/3 percent war surcharge.

As long as British celestite can be laid down at eastern seaboard docks for \$20 or less per short ton, some dealers believe that western producers will be compelled to take as low as \$5 or \$6 a ton f. o. b. mine if they wish to enter the market.

Shipments of celestite from Mexico during the first 7 months of 1941 were valued at \$16 a short ton at the port of origin, and shipping rates were roughly comparable to transatlantic rates.

During the early part of World War I (1915) the price of celestite f. o. b. Bristol dock was about \$3 a short ton, and in 1933-34 it had risen to about \$7 a short ton at the dock.

The price of German strontianite at the mine has ranged from \$50 to \$70 per short ton in recent years.

PRODUCERS OF STRONTIUM ORES IN 1940

California

D. A. Eschelbach, Edg. Co., Inc., 383 Brannon St., San Francisco. (Celestite.)

E. I. du Pont de Nemours & Co., Wilmington, Del. Mine, Argos (shipping point, Ludlow), San Bernardino County. (Celestite.)

Pan Chemical Co., 1396 North Harvard St., Claremont Mine, Imperial County; shipping point, Westmoreland. (Celestite.)

California (cont'd.)

C. Solomon, Jr., 2457 Scott St., San Francisco Mine, Barstow, San Bernardino County. (Strontianite.)

Wm. C. Buehler, 1555 Sunset Ave., Pasadena; shipping point, Lavic. (Celestite.)

Ohio

United States Gypsum Co., 300 West Adams St., Chicago, Ill. Mine, Genoa, Sandusky County. (Celestite, produced as by-product in limestone operation.)

Texas

Mudrite Chemicals Inc., P. O. Box 1013, Houston. Mine, Sweetwater, Nolan County. (Celestite, sold for oil-well drilling).

Washington

Manufacturers Mineral Co., Seattle. Mine, La Conner, Skagit County. (Celestite and strontianite.)

BUYERS

Delaware

E. I. du Pont de Nemours & Co., Inc., 11th & Orange St., Wilmington. (also a producer.)

New York

General Electric Co., 1 River Road, Schenectady.

New York City

Associated Metals & Minerals Corporation, 40 Rector St.
Chas. Hardy, 415 Lexington Ave.
Hummel Chemical Co., 90 West St.
Jungman & Co., 157 Chambers St.
J. A. Samuel & Co., 220 Broadway.

Ohio

Barium & Chemicals, Inc., Willoughby.

Harshaw Chemical Co., 1933 E. 97th St., Cleveland.

Pennsylvania

Foote Mineral Co., Inc., 1609 Summer St., Philadelphia.

West Virginia

Barium Reduction Corporation, South Charleston.